

**We claim:**

1. A process for producing controllable yields of a combination of products selected from the group consisting of (a) phenol and methyl ethyl ketone (MEK)  
5 and (b) phenol, acetone, and MEK, said process comprising:

feeding an oxidation feed to an oxidation reactor to produce an oxidation mixture, the oxidation feed comprising one or more alkylbenzenes  
10 selected from the group consisting of (a) a content of s-butylbenzene, and (b) a combination of s-butylbenzene and cumene at a weight ratio of cumene to s-butylbenzene;  
exposing the oxidation mixture to oxidation  
15 conditions effective to produce an oxidation product stream comprising product hydroperoxides selected from the group consisting of (a) s-butylbenzene hydroperoxide, and (b) a combination of s-butylbenzene  
20 hydroperoxide and cumene hydroperoxide;  
cleaving the product hydroperoxides under cleavage conditions effective to produce a cleavage product comprising a combination selected from the group consisting of (a) phenol and MEK, and  
25 (b) phenol, acetone, and MEK; and,  
separating the cleavage product under separation conditions effective to separate a crude phenol fraction comprising phenol and a crude ketone stream selected from the group consisting of  
30 (a) a crude MEK stream and (b) a crude acetone/MEK stream comprising MEK and acetone;  
and,  
recovering one or more products selected from the group consisting of (a) an MEK product and (b)  
35 a combination comprising an MEK product and an acetone product.

2. The process of claim 1 wherein said oxidation conditions comprise feeding the oxidation mixture to one

or more continuous oxidation reactors and feeding a source of molecular oxygen to the oxidation mixture.

3. The process of claim 1 wherein said oxidation conditions comprise feeding said oxidation mixture to a series of continuous oxidation reactors and feeding a source of molecular oxygen to the oxidation mixture.

4. The process of claim 3 further comprising separating the oxidation product stream under oxidation separation conditions effective to produce an oxidation bottoms (OB) and an oxidation vapor overhead.

5. The process of claim 4 wherein the oxidation conditions are effective to produce an oxidation product stream further comprising:

major byproducts selected from the group consisting of acetophenone, di-methyl benzyl carbinol (DMBA), and ethyl methyl benzyl carbinol (EMBA), and combinations thereof; and minor by-products selected from the group consisting of di-cumyl peroxide, di-s-butylperoxide, cumyl s-butyl peroxide, formic acid, acetic acid, methanol, ethanol, methyl hydroperoxide, ethyl hydroperoxide, phenol, acetone, and MEK, and combinations thereof.

6. The process of claim 4 wherein the weight ratio of cumene to s-butylbenzene is from about 1:8 (or 12.5 wt.% cumene) to about 2:1 (or about 66.7 wt.% cumene).

7. The process of claim 1 wherein the oxidation reactor is a batch oxidation reactor and the oxidation conditions comprise:

an oxidation temperature of from about 90 °C to about 150 °C;  
an oxidation pressure of from about 0 psig to about 100 psig; and,  
an oxidation reaction time of from about 6 to about 11 hours.

8. The process of claim 7 wherein the oxidation pressure is from about 15 psig to about 40 psig.

9. The process of claim 4 wherein the oxidation conditions comprise:

an oxidation temperature of from about 100 °C to about 130 °C.;

5 an oxidation pressure of from about 0 psig to about 100 psig; and,

a total residence time in each continuous reactor of from about 1 to about 5 hours.

10 10. The process of claim 9 wherein the oxidation pressure is from about 15 psig to about 40 psig.

11. The process of claim 4 wherein the oxidation conditions are effective to produce about 5% or more conversion to the product hydroperoxides.

15 12. The process of claim 4 wherein the oxidation conditions are effective to produce from about 10% to about 30% conversion to the product hydroperoxides.

13. The process of claim 4 wherein the oxidation conditions are effective to produce from about 15% to about 25% conversion to the product hydroperoxides.

20 14. The process of claim 4 wherein the series of continuous oxidation reactors comprises from about 3 to about 8 continuous reactors in series.

25 15. The process of claim 10 wherein the series of continuous oxidation reactors comprises from about 3 to about 8 continuous reactors in series.

16. The process of claim 4 wherein the weight ratio of cumene to s-butyl benzene is 2:1, and the series of continuous oxidation reactors are 4 continuous oxidation reactors in series.

30 17. The process of claim 4 wherein the weight ratio of cumene to s-butylbenzene is 1:8 and the series of continuous oxidation reactors are from 5 to 6 continuous oxidation reactors in series.

35 18. The process of claim 4 further comprising cooling the oxidation vapor overhead and the oxidation reaction mixture.

19. The process of claim 18 wherein said cooling comprises exchanging heat between the oxidation mixture and cooling fluids.

20. The process of claim 19 further comprising  
5 recirculating the oxidation mixture to heat exchangers external to the one or more oxidation reactors.

21. The process of claim 18 further comprising:  
separating the oxidation vapor overhead into an  
oxidation vapor overhead-organic fraction (OVO-  
10 OF) and an oxidation vapor overhead aqueous  
fraction (OVO-AF);

decomposing the OVO-AF under thermal decomposition  
conditions effective to decompose ethyl  
hydroperoxide and methyl hydroperoxide to  
15 produce a thermal decomposition product  
comprising alcohols, aldehydes, carboxylic  
acids, and combinations thereof, said thermal  
decomposition conditions comprising a thermal  
decomposition temperature of from about 80°C to  
20 250°C. and a thermal decomposition pressure of  
from about 100 psig to about 200 psig.

22. The process of claim 18 further comprising  
separating the oxidation vapor overhead into an  
oxidation vapor overhead organic fraction  
25 ("OVO-OF") and an oxidation vapor overhead  
aqueous fraction ("OVO-AF");

decomposing the OVO-AF under thermal decomposition  
conditions effective to decompose ethyl  
hydroperoxide and methyl hydroperoxide to  
30 produce a thermal decomposition product  
comprising alcohols, aldehydes, carboxylic  
acids, and combinations thereof, said thermal  
decomposition conditions comprising adding an  
OVO-AF inorganic acid to the OVO-AF under  
35 conditions effective to accelerate the  
decomposition and neutralizing the OVO-AF  
inorganic acid with an OVO-AF alkali base  
having a pH of from about 10 to about 11; and,

distilling the thermal decomposition product under thermal decomposition product distillation conditions (TDP-distillation conditions) comprising a TDP-distillation temperature effective to remove organic species other than carboxylic acids from the first decomposition product, said TDP-distillation conditions being effective to produce a thermal decomposition product organic distillate and a thermal decomposition product aqueous bottoms.

23. The process of claim 22 wherein the OVO-AF inorganic acid is selected from the group consisting of sulfuric acid, hydrochloric acid, and phosphoric acid.

24. The process of claim 22 wherein the OVO-AF inorganic acid is sulfuric acid.

25. The process of claim 24 wherein the OVO-AF inorganic acid is added to a concentration of from about 20 ppm to about 100 ppm in the OVO-AF.

26. The process of claim 25 further comprising neutralizing the OVO-AF inorganic acid with an OVO-AF base selected from the group consisting of sodium carbonate and sodium hydroxide.

27. The process of claim 4 further comprising feeding the OB and a quantity of water to one or more strippers and exposing the OB to stripping conditions effective to concentrate but ineffective to decompose hydroperoxides selected from the group consisting of s-butylbenzene hydroperoxide, cumene hydroperoxide, and combinations thereof, the stripping conditions being effective to produce a stripper overhead and a stripper bottoms comprising the hydroperoxides, said quantity of water being effective to produce a first condenser vapor phase comprising a majority of water, ethanol, methanol, methyl hydroperoxide, ethyl hydroperoxide, and combinations thereof, in the first stripper overhead.

28. The process of claim 27 wherein said quantity of water is equivalent to from about 0.1 wt.% to about 1.5 wt.% of the oxidation bottoms.

29. The process of claim 6 further comprising feeding the OB and a quantity of water to one or more strippers and exposing the OB to stripping conditions effective to concentrate but ineffective to decompose hydroperoxides selected from the group consisting of s-butylbenzene hydroperoxide, cumene hydroperoxide, and combinations thereof, the stripping conditions being effective to produce a stripper overhead and a stripper bottoms comprising the hydroperoxides, said quantity of water being effective to produce a first condenser vapor phase comprising a majority of water, ethanol, methanol, methyl hydroperoxide, ethyl hydroperoxide, and combinations thereof, in the first stripper overhead.

30. The process of claim 29 wherein said quantity of water is equivalent to from about 0.1 wt.% to about 1.5 wt.% of the oxidation bottoms.

31. The process of claim 9 further comprising feeding the OB and a quantity of water to one or more strippers and exposing the OB to stripping conditions effective to concentrate but ineffective to decompose hydroperoxides selected from the group consisting of s-butylbenzene hydroperoxide, cumene hydroperoxide, and combinations thereof, the stripping conditions being effective to produce a stripper overhead and a stripper bottoms comprising the hydroperoxides, said quantity of water being effective to produce a first condenser vapor phase comprising a majority of water, ethanol, methanol, methyl hydroperoxide, ethyl hydroperoxide, and combinations thereof, in the first stripper overhead.

32. The process of claim 31 wherein said quantity of water is equivalent to from about 0.1 wt.% to about 1.5 wt.% of the oxidation bottoms.

33. The process of claim 27 wherein the stripper overhead comprises unreacted hydrocarbon, dissolved water, and organic species having a boiling point lower than s-butylbenzene hydroperoxide selected from the group consisting of minor by-products, DMBA, EMBA, acetophenone, and combinations thereof.

34. The process of claim 33 wherein the stripping conditions comprise a stripper bottoms temperature of about 120 °C or less.

35. The process of claim 34 further comprising  
5 feeding the OB through multiple strippers.

36. The process of claim 35 wherein the multiple strippers comprise three strippers in series.

37. The process of claim 36 wherein the stripping conditions comprise

10 first stripper conditions effective to produce a first stripper bottoms and a first stripper overhead comprising a portion of the one or more alkylbenzenes in the OB,  
second stripper conditions effective to produce a  
15 second stripper overhead and a second stripper bottoms, and  
third stripper conditions effective to produce a third stripper overhead and third stripper bottoms,  
20 wherein said stripping conditions comprise a first stripper pressure greater than a second stripper pressure greater than a third stripper pressure.

38. The process of claim 37 wherein  
25 said first stripper pressure is from about 40 to about 60 mm Hg;  
said second stripper pressure is from about 25 to about 35 mm Hg; and,  
said third stripper pressure is from about 10 to  
30 about 20 mm Hg.

39. The process of claim 37 wherein  
said first stripper pressure is about 50 mm Hg;  
said second stripper pressure is about 30 mm Hg;  
and,  
35 said third stripper pressure is about 15 mm Hg.

40. The process of claim 37 wherein the first stripper conditions are effective to produce a first stripper overhead comprising:

99 wt.% or more of the water fed with the OB;  
99 wt.% or more of methanol in the OB;  
99 wt.% or more of ethanol in the OB;  
99 wt.% or more of methyl hydroperoxide in the OB;

5 and,

99 wt.% or more of ethyl hydroperoxide in the OB.

41. The process of claim 37 wherein the first  
stripper conditions are effective to produce a first  
stripper overhead comprising:

10 all water fed with the OB;  
all methanol in the OB;  
all ethanol in the OB;  
all methyl hydroperoxide in the OB;  
all ethyl hydroperoxide in the OB.

15 42. The process of claim 37 further comprising  
exposing the first stripper overhead to first stripper  
overhead condenser conditions comprising a first stripper  
overhead condensation temperature and a first stripper  
overhead condensation pressure, said first stripper  
20 overhead condenser conditions being effective to cause a  
majority of the one or more alkylbenzenes in the first  
stripper overhead to condense, producing a first  
condenser organic phase, said first stripper overhead  
condenser conditions and said quantity of water also  
25 being effective to produce a first condenser vapor phase  
comprising a majority of water, ethanol, methanol, methyl  
hydroperoxide, ethyl hydroperoxide, and combinations  
thereof, in the first stripper overhead.

30 43. The process of claim 42 wherein the first  
condenser organic phase comprises:

about 90 wt.% or more of the s-butylbenzene in the  
first stripper overhead; and,  
if present, about 85 wt.% or more of cumene in the  
first stripper overhead.

35 44. The process of claim 43 wherein the first  
stripper overhead condensation temperature and the first  
stripper overhead condensation pressure are effective to  
produce a first condenser vapor phase comprising about 95  
wt.% or more of each of the water, the ethanol, the



methanol, the methyl hydroperoxide, the ethyl hydroperoxide, and combinations thereof, in the first stripper overhead.

5        45. The process of claim 44 further comprising  
condensing the first condenser vapor phase to second  
condensation conditions effective to form a second  
condenser organic phase and a second condenser aqueous  
phase comprising a majority of each of the ethanol, the  
methanol, the methyl hydroperoxide, the ethyl  
10       hydroperoxide in the first condenser vapor phase, and  
combinations thereof.

      46. The process of claim 45 further comprising  
subjecting the second condenser aqueous phase to said  
decomposition conditions, producing a decomposition  
15       product comprising alcohols, aldehydes, carboxylic acids,  
and combinations thereof.

      47. The process of claim 37 further comprising  
recycling greater than about 90 wt.% of the hydrocarbons  
in the OB to the oxidation mixture.

20       48. The process of claim 1 wherein said cleaving  
comprises:  
      feeding a cleavage reaction feed to a cleavage  
      reactor to produce a cleavage reaction mixture  
      comprising the one or more hydroperoxides; and  
25       subjecting the cleavage reaction mixture to cleavage  
      reaction conditions effective to produce a  
      cleavage reaction product comprising phenol and  
      one or more component selected from the group  
      consisting of methyl ethyl ketone, acetone, and  
30       combinations thereof;  
      wherein the cleavage reaction conditions comprise a  
      cleavage reaction temperature which is  
      sufficiently high to cleave a majority of the  
      one or more hydroperoxides but sufficiently low  
35       to produce a first quantity of non-recoverable  
      byproducts from components selected from the  
      group consisting of DMBA, EMBA, and  
      combinations thereof, the first quantity of the  
      non-recoverable by-products being less than a

second quantity of the non-recoverable byproducts produced by the same process at a cleavage reaction temperature of 75 °C or higher.

- 5        49. The process of claim 48 wherein said cleaving further comprises:

10        feeding to a first cleavage reactor a first cleavage reaction feed comprising at least a portion of the third stripper bottoms and an acid catalyst effective to catalyze the cleavage of hydroperoxides selected from the group consisting of s-butylbenzene hydroperoxide, cumene hydroperoxide, and combinations thereof, the first cleavage reaction conditions being effective to produce a first cleavage reaction mixture comprising a first cleavage reaction product; and,

15        feeding the first cleavage reaction product to a second cleavage reactor to produce a second cleavage reaction mixture and subjecting the second cleavage reaction mixture to second cleavage reaction conditions effective to produce a second cleavage reaction product, said second cleavage reaction conditions comprise a second cleavage reaction temperature effective to convert DMBA to  $\alpha$ -methyl styrene and to convert EMBA to a compound selected from the group consisting of  $\alpha$ -ethyl styrene (AES), 2-phenyl-2-butene (2P2B), and combinations thereof.

- 20        50. The process of claim 48 wherein the cleavage reaction feed is a first cleavage reaction feed to a first cleavage reactor, and the cleavage conditions comprise first cleavage reaction conditions effective to produce a first cleavage reaction mixture comprising a first cleavage reaction product, said process further comprising feeding the first cleavage reaction product to a second cleavage reactor to produce a second cleavage

reaction mixture and subjecting the second cleavage reaction mixture to second cleavage reaction conditions effective to produce a second cleavage reaction product, said second cleavage reaction conditions comprising a  
5 second cleavage reaction temperature effective to convert DMBA to  $\alpha$ -methyl styrene and to convert EMBA to a compound selected from the group consisting of  $\alpha$ -ethyl styrene (AES), 2-phenyl-2-butene (2P2B), and combinations thereof.

10 51. The process of claim 49 wherein the first cleavage reactor and the second cleavage reactor are selected from the group consisting of plug-flow reactors (PFR's), plug-flow reactors with recycle (PFRR's), and continuous stirred tank reactors (CSTR's).

15 52. The process of claim 49 wherein the first cleavage reactor is a stirred tank reactor comprising internal or external heat exchangers effective to maintain the first cleavage reaction mixture at the first cleavage reaction temperature.

20 53. The process of claim 49 wherein the first cleavage reactor is a PFRR comprising one or more heat exchangers effective to maintain the first cleavage reaction mixture at the first cleavage reaction temperature.

25 54. The process of claim 49 wherein the first cleavage reaction conditions comprise:

a first cleavage reaction temperature of from about 45°C to about 70°C; and,

30 a first cleavage reaction pressure sufficiently high to maintain the first cleavage reaction mixture in the liquid phase.

55. The process of claim 54 wherein the first cleavage reaction temperature is from about 45°C to about 60°C.

35 56. The process of claim 49 wherein the first cleavage reaction conditions comprise

a first cleavage reaction temperature is from about  
45°C to about 55°C; and,

a first cleavage reaction pressure is about 0.5  
atmospheres or more.

5        57. The process of claim 54 wherein the first  
cleavage reaction conditions comprise recirculating a  
recycle flow of the first cleavage reaction mixture  
through the first cleavage reactor.

10       58. The process of claim 57 further comprising  
withdrawing the first cleavage reaction product from the  
first cleavage reactor upstream of the first cleavage  
reactor feed.

15       59. The process of claim 57 wherein the recycle  
flow through the first cleavage reactor is greater than  
the first cleavage reactor feed flow.

60. The process of claim 57 wherein the ratio of  
the recycle flow through the first cleavage reactor  
compared to the first cleavage reactor feed flow is from  
about 10:1 to about 100:1 on a weight basis.

20       61. The process of claim 57 wherein the ratio of  
the recycle flow through the first cleavage reactor  
compared to the first cleavage reactor feed flow is from  
about 20:1 to 40:1 on a weight basis.

25       62. The process of claim 59 wherein the first  
cleavage reaction conditions comprise a first cleavage  
reaction residence time effective to cleave:

about 95% or more of s-butylbenzene hydroperoxide in  
the first cleavage reaction mixture to phenol  
and MEK; and,

30       if present, about 95% or more of cumene  
hydroperoxide in the first cleavage reaction  
mixture to phenol and acetone.

35       63. The process of claim 61 wherein the first  
cleavage reaction residence time is from about 1 minute  
to about 10 minutes.

64. The process of claim 59 wherein the acid  
catalyst is selected from the group consisting of

sulfuric acid, sulfuric acid anhydride, perchloric acid, phosphoric acid, and combinations thereof.

65. The process of claim 59 wherein the acid catalyst comprises sulfuric acid.

5        66. The process of claim 59 further comprising adding the acid catalyst to a first cleavage reaction mixture side stream at one or more acid addition points and withdrawing the first cleavage reaction mixture side stream between the first cleavage reaction product  
10 withdrawal point and the first cleavage reactor feed point.

67. The process of claim 66 wherein the amount of acid catalyst fed to the first cleavage reactor is from about 0.005% to about 0.1% by weight based on the first  
15 cleavage reactor feed flow.

68. The process of claim 59 wherein the second cleavage reactor comprises a once through plug flow reactor.

69. The process of claim 67 wherein the second  
20 cleavage reactor comprises a once through plug flow reactor.

70. The process of claim 59 wherein the second cleavage reaction conditions comprise a second cleavage reaction temperature and a second cleavage reaction  
25 residence time effective to cleave 95 wt.% or more of the hydroperoxides in the second cleavage reaction mixture.

71. The process of claim 70 wherein the second cleavage reaction conditions are effective to convert:

75 wt.% or more of DMBA in the first cleavage  
30 reaction product to AMS; and  
75 wt.% or more of EMBA in the first cleavage reaction product to a compound selected from the group consisting of AES, 2P2B, and combinations thereof.

35        72. The process of claim 70 wherein the second cleavage reaction conditions are effective to convert:

85 wt.% or more of DMBA in the first cleavage reaction product to AMS; and

85 wt.% or more of EMBA in the first cleavage reaction product to a compound selected from the group consisting of AES, 2P2B, and combinations thereof.

5        73. The process of claim 59 wherein the second cleavage reaction conditions comprise:

a second cleavage reaction temperature of from about 60 °C to about 130 °C; and

10        a second cleavage reaction pressure which, when combined with the second cleavage reaction temperature, is sufficient to maintain the second cleavage reaction mixture in the liquid phase; and,

15        a second cleavage reaction residence time of from about 5 seconds to about 1 minute.

74. The process of claim 59 wherein the second cleavage reaction temperature is from about 70 °C to about 120 °C; and,

20        the second cleavage reaction pressure is about 30 psig or more.

75. The process of claim 71 further comprising taking multiple exotherm measurements to verify the rate of the cleavage reaction.

25        76. The process of claim 75 further comprising controlling the amount of acid catalyst added to the first cleavage reaction mixture based on the multiple exotherm measurements.

77. The process of claim 75 wherein taking the multiple exotherm measurements comprises:

30        taking a first reaction mixture side stream exotherm measurement;

taking a first cleavage reactor (FCR) exotherm measurement; and,

35        taking a second cleavage reactor (SCR) exotherm measurement.

78. The process of claim 71 further comprising cooling and neutralizing the second cleavage reaction product with an amount of a second

cleavage reaction product neutralizing base  
under second cleavage reaction product  
neutralization conditions effective to produce  
a neutralized second cleavage reaction product,  
5 the second cleavage reaction product  
neutralization conditions comprising a second  
cleavage reaction product neutralization  
pressure sufficient to maintain the second  
cleavage reaction product in the liquid phase;  
10 and,

separating the neutralized second cleavage reaction  
product into a neutralized second cleavage  
reaction product aqueous fraction and a CKC  
feed comprising a neutralized second cleavage  
15 reaction product organic fraction.

79. The process of claim 78 wherein the second  
cleavage reaction product neutralization conditions  
comprise

a temperature of from about 40 °C to about 60 °C;  
20 and,  
a second cleavage reaction pressure which, when  
combined with the second cleavage reaction  
temperature, is sufficient to maintain the  
second cleavage reaction mixture in the liquid  
25 phase.

80. The process of claim 79 wherein the second  
cleavage reaction product neutralization temperature is  
from about 45 °C to about 50 °C.

81. The process of claim 80 wherein said amount of  
30 second cleavage reaction product neutralizing base  
comprises an amount of alkali base, said amount being  
effective to maintain the neutralized the second cleavage  
reaction product aqueous fraction at a pH of from about 5  
to about 11.

82. The process of claim 80 wherein said amount of  
35 second cleavage reaction product neutralizing base is  
effective to maintain the neutralized second cleavage

reaction product aqueous fraction at a pH of from about 5 to about 5.5.

83. The process of claim 80 wherein the second cleavage reaction product neutralizing base comprises an  
5 alkali base selected from the group consisting of hydroxides, carbonates, bicarbonates, and phenates of sodium, potassium, and lithium, and combinations thereof.

84. The process of claim 80 wherein the weight  
10 ratio of the CKC feed to the neutralized second cleavage reaction product aqueous fraction is from about 1:3 to about 3:1.

85. The process of claim 84 further comprising  
15 circulating at least part of the neutralized second cleavage reaction product aqueous fraction back to a neutralization apparatus.

86. The process of claim 84 further comprising  
maintaining the salt concentration in the neutralized  
second cleavage reaction product aqueous fraction at from  
about 1 to about 30% by weight.

20 87. The process of claim 1 further comprising feeding a CKC feed comprising a neutralized organic fraction from said cleavage product to a cleavage product separation zone and exposing the CKC feed to CKC conditions effective to produce

25 a crude phenol fraction comprising from about 2 wt.% to about 5 wt.% of a combination of the one or more alkylbenzenes, AMS, AES, and 2P2B; and, a CKC vapor distillate comprising most of the water, the one or more alkylbenzenes, AMS, AES, 2P2B,  
30 and combinations thereof in the CKC feed.

88. The process of claim 87 wherein the CKC  
conditions are effective to produce a CKC vapor  
distillate comprising 99 wt.% or more of water in the  
CKC feed and 75% or more of the hydroxy-ketones in the  
35 CKC feed.

89. The process of claim 87 wherein the CKC  
conditions are effective to produce a CKC vapor  
distillate comprising all water in the CKC feed.



90. The process of claim 87 wherein the CKC conditions comprise

a CKC top temperature of from about 190°C to about 220°C;

5 a CKC top pressure of from about 0 psig to about 10 psig; and,  
a minimum mass reflux ratio of about 0.05/1.

91. The process of claim 87 wherein the CKC conditions comprise

10 a CKC top temperature of from about 203°C to 207°C;  
a CKC top pressure of from about 3 psig to about 7 psig; and,  
a mass reflux ratio of from about 0.1/1 to about 0.2/1.

15 92. The process of claim 87 further comprising  
condensing the CKC vapor distillate to produce a CKC vapor condensate, said condensing comprising  
feeding the CKC vapor distillate to a CKC vapor condenser and subjecting the CKC vapor  
20 distillate to CKC vapor condenser conditions effective to produce the CKC vapor condensate;  
and,

exposing the CKC vapor condensate to CKC vapor condensate separation conditions effective to  
25 produce a CKC vapor condensate organic layer and a CKC vapor condensate aqueous layer.

93. The process of claim 92 further comprising feeding a CKC recycle portion of the CKC vapor condensate aqueous layer to the CKC column at a recycle point.

30 94. The process of claim 93 wherein the recycle point is the same tray at which the CKC feed is fed to the CKC column.

95. The process of claim 94 wherein the CKC recycle portion comprises from about 50 wt.% to 95 wt.% of the  
35 CKC vapor condensate aqueous layer.

96. The process of claim 94 wherein the CKC recycle portion comprises from about 75 wt.% to about 80 wt.% of the CKC vapor condensate aqueous layer.

97. The process of claim 93 further comprising  
mixing a remainder of the CKC vapor condensate aqueous  
layer with the CKC vapor condensate organic layer to form  
a CKC vapor condensate mixture comprising 2 wt.% phenol  
5 or less.

98. The process of claim 97 wherein the CKC vapor  
condensate mixture comprises about 1 wt.% phenol or less.

99. The process of claim 87 further comprising  
feeding a CKC vapor condensate mixture from said CKC feed  
10 comprising 2 wt.% phenol or less to a MEK recovery zone  
and exposing the CKC vapor condensate mixture to MEK  
recovery conditions effective to produce a MEK product.

100. The process of claim 98 further comprising  
feeding the CKC vapor condensate mixture to a MEK  
15 recovery zone and exposing the CKC vapor condensate  
mixture to MEK recovery conditions effective to produce a  
MEK product.

101. The process of claim 100 wherein the MEK  
recovery conditions comprise  
20 mixing the CKC vapor condensation mixture with an  
amount of a MEK recovery alkali base effective  
to condense a majority of aldehydes in the CKC  
vapor condensate mixture with MEK and to  
convert a majority of phenol in the CKC vapor  
25 condensate mixture to sodium phenate, thereby  
producing a MEK recovery mixture; and,  
subjecting the MEK recovery mixture to MEK  
separation conditions effective to separate a  
MEK product.

30 102. The process of claim 101 wherein the MEK  
recovery alkali base is sodium hydroxide.

103. The process of claim 101 wherein the MEK  
separation conditions comprise  
cooling the MEK recovery mixture to a MEK recovery  
35 temperature of from about 35 °C to about 55 °C  
to produce a cooled MEK recovery mixture; and,  
exposing the cooled MEK recovery mixture to MEK  
recovery mixture separation conditions

effective to separate the cooled MEK recovery mixture into a first MEK aqueous stream and a first MEK organic stream.

104. The process of claim 103 wherein the MEK  
5 recovery temperature is from about 40 °C to about 45 °C.

105. The process of claim 103 further comprising recirculating the first MEK aqueous stream to the cleavage neutralization apparatus.

106. The process of claim 103 further comprising  
10 washing the first MEK organic stream with aqueous alkali base under first MEK organic stream washing conditions effective to remove trace phenol, producing a first washed MEK organic phase;  
15 washing the first washed MEK organic phase with an aqueous wash under conditions effective to remove trace alkali base and to produce a twice washed MEK organic stream; and,  
subjecting the twice washed MEK organic stream to  
20 twice washed MEK organic stream separation conditions effective to produce a twice washed MEK aqueous phase and a MDC feed comprising a twice washed MEK organic phase.

107. The process of claim 103 further comprising  
25 decanting the cooled MEK recovery mixture under MEK recovery mixture decanting conditions effective to separate the cooled MEK recovery mixture into a MEK decanter aqueous stream and a MEK decanter organic stream comprising MEK, hydrocarbon, other organic species,  
30 dissolved water, and combinations thereof.

108. The process of claim 107 further comprising recirculating the MEK decanter aqueous stream to the cleavage neutralization apparatus.

109. The process of claim 107 further comprising  
35 subjecting the first washed MEK organic stream to first washed MEK organic stream separation conditions effective to produce a first washed MEK aqueous phase and a first washed MEK

organic , producing a first washed MEK decanter organic stream;  
washing the MEK decanter organic stream with aqueous alkali base under MEK-decanter organic stream  
5 washing conditions effective to remove trace phenol;  
separating the first washed MEK decanter organic stream under first washed MEK decanter organic stream separating conditions effective to  
10 separate the first washed MEK decanter organic stream into a first washed MEK decanter aqueous phase and a first washed MEK decanter organic phase;  
washing the first washed MEK decanter organic phase  
15 with an aqueous wash under conditions effective to remove trace alkali base and to produce a twice washed MEK decanter organic stream;  
exposing the twice washed MEK decanter organic stream to twice washed MEK decanter organic  
20 stream separation conditions effective to produce a twice washed MEK decanter aqueous phase and an MDC feed comprising a twice washed MEK decanter organic phase, the MDC feed comprising MEK, hydrocarbon, water, other  
25 organic species, and combinations thereof.

110. The process of claim 109 further comprising subjecting said MDC feed to MDC conditions effective to produce a MDC overhead comprising water and organic species having a boiling point sufficiently lower than  
30 MEK to be separated from the MEK.

111. The process of claim 110 wherein the MDC conditions comprise a MDC entrainer effective to remove water from the MDC feed.

112. The process of claim 111 wherein the MDC  
35 entrainer is selected from the group consisting of hexane, cyclohexane, heptane, and combinations thereof.

113. The process of claim 111 wherein the MDC entrainer is cyclohexane.

114. The process of claim 110 wherein the MDC conditions comprise

a MDC pressure of from about 3 to about 10 psig;  
a MDC temperature of from about 75 °C to about 90 °C;

5 and,

a minimum MDC molar reflux ratio of about 5/1 based on the reflux flow to the overhead water flow.

115. The process of claim 110 wherein the MDC conditions comprise

10 a MDC pressure of from about 6 to about 7 psig;  
a MDC temperature of from about 80 °C to about 85 °C.; and,

15 a MDC molar reflux ratio of from about 10/1 to about 20/1 based on the reflux flow to the overhead water flow.

116. The process of claim 110 further comprising subjecting the MDC bottoms to MPC conditions effective to separate the MDC bottoms into a MPC bottoms comprising hydrocarbons and organic species having a boiling point  
20 higher than MEK and a MPC overhead comprising product MEK.

117. The process of claim 116 wherein the MPC overhead comprises a MPC purge stream comprising MEK, the MPC purge stream being effective to purge organic species  
25 having a boiling point less than MEK from the MPC.

118. The process of claim 116 wherein the MPC conditions are effective to produce MEK product as a side draw from the MPC.

119. The process of claim 117 wherein the MPC conditions are effective to produce MEK product as a side  
30 draw from the MPC.

120. The process of claim 116 wherein the MPC conditions comprise

35 a MPC top pressure of from about 0 psig to about 10 psig;

a MPC top temperature of from about 85 °C to about 101 °C; and,

a MPC molar reflux ratio, based on reflux flow to MEK product flow, of 0.15 or greater.

121. The process of claim 116 wherein the MPC conditions comprise

5 a MPC top pressure of from about 4 psig to about 6 psig;

a MPC top temperature of from about 92 °C to about 95 °C; and,

10 a MPC molar reflux ratio, based on reflux flow to MEK product flow, of greater than 0.15.

122. The process of claim 121 wherein the MPC molar reflux ratio is from about 0.15 to about 1.

123. The process of claim 121 wherein the MPC molar reflux ratio is about 1/1.

15 124. The process of claim 1 wherein the acetone/MEK separation conditions comprise feeding the acetone/MEK stream to an Acetone Product Column (APC) as an APC feed and subjecting the APC feed to APC conditions effective to produce an APC product comprising an APC overhead  
20 comprising an APC purge stream comprising acetone, said APC product further comprising substantially pure product acetone as a side draw.

125. The process of claim 87 wherein the acetone/MEK separation conditions comprise feeding the acetone/MEK  
25 stream to an Acetone Product Column (APC) as an APC feed and subjecting the APC feed to APC conditions effective to produce an APC product comprising an APC overhead comprising an APC purge stream comprising acetone, said APC product further comprising substantially pure product  
30 acetone as a side draw.

126. The process of claim 125 wherein the CKC conditions are effective to produce an APC feed comprising less than 2 wt.% phenol.

127. The process of claim 126 wherein the CKC  
35 conditions are effective to produce an APC feed comprising from about 14 wt.% to about 45 wt.% acetone and from about 46 wt.% to about 15 wt.% MEK.

128. The process of claim 125 wherein the oxidation feed comprises from about 15 wt.% to about 30 wt.% cumene, and the CKC conditions are effective to produce an APC feed comprising from about 16 to about 28 wt.% acetone and from about 44 to about 32 wt.% MEK, respectively.

129. The process of claim 125 further comprising feeding to the first cleavage reactor an amount of a recycle stream effective to reduce the production of non-recoverable by-products from DMBA, EMBA, and a combination thereof, said recycle stream being selected from the group consisting of the MPC purge stream, the APC purge stream, and a combination thereof.

130. The process of claim 129 wherein said amount of said recycle stream is about 0.1 pound or more of recycle stream per pound of third stripper bottoms.

131. The process of claim 125 wherein the APC conditions comprise feeding to the APC column an APC base effective to catalyze the condensation of aldehydes in the APC feed with MEK and acetone to produce an APC bottoms comprising MEK, hydrocarbon, APC condensation reaction products, sodium phenate, and combinations thereof; and, subjecting the APC bottoms to MEK separation conditions effective to separate MEK product.

132. The process of claim 131 wherein the APC base is an alkali base.

133. The process of claim 131 wherein the APC base is sodium hydroxide.

134. The process of claim 125 wherein the APC conditions comprise an APC top pressure of from about 400 to about 500 mm Hg; an APC top temperature of from about 30 °C to about 50 °C.; and, a minimum APC molar reflux ratio is about 12/1.

135. The process of claim 125 wherein the APC conditions comprise

an APC top pressure of about 450 mm Hg;

an APC top temperature of about 40 °C.; and,

5 an APC molar reflux ratio of from about 15/1 to about 27/1, calculated as rate of reflux flow to side draw product flow on a molar basis.

136. The process of claim 135 wherein the APC molar reflux ratio of about 21/1 or greater, calculated as rate  
10 of reflux flow to side draw product flow on a molar basis.

137. The process of claim 131 wherein the MEK separation conditions comprise

cooling the APC bottoms to a cooled APC bottoms  
15 temperature of from about 35 °C to about 55 °C; and,

exposing the cooled APC bottoms to cooled APC bottoms separation conditions effective to produce an APC aqueous stream and an APC  
20 organic stream comprising MEK, hydrocarbon, other organic species, dissolved water, and combinations thereof.

138. The process of claim 137 wherein said cooled APC bottoms temperature is from about 40 °C to about 45  
..25 °C.

139. The process of claim 137 further comprising recycling the APC aqueous stream to the cleavage neutralization apparatus.

140. The process of claim 137 further comprising  
30 washing the APC organic stream with aqueous alkali base under APC organic stream washing conditions effective to remove trace phenol and to produce a first washed APC organic stream; separating the first washed APC organic stream under  
35 first washed APC separation conditions effective to separate the first washed APC organic stream into a first washed APC aqueous phase and a first washed APC organic phase;



washing the first washed APC organic phase with an aqueous wash under conditions effective to remove trace alkali base and to produce a twice washed APC organic stream; and,

5 separating the twice washed APC organic stream under twice washed APC organic stream separation conditions effective to produce a twice washed APC aqueous phase and a MDC feed comprising a twice washed APC organic phase.

10 141. The process of claim 140 wherein the APC organic stream separation conditions are decanter separation conditions.

142. The process of claim 137 wherein the cooled APC bottoms separation conditions comprise decanting the

15 cooled APC bottoms into an APC decanter aqueous stream and an APC decanter organic stream comprising MEK, hydrocarbon, other organic species, dissolved water, and combinations thereof.

143. The process of claim 140 wherein the cooled APC

20 bottoms separation conditions comprise decanting the cooled APC bottoms into an APC decanter aqueous stream and an APC decanter organic stream comprising MEK, hydrocarbon, other organic species, dissolved water, and combinations thereof.

25 144. The process of claim 143 further comprising recycling the APC decanter aqueous stream to the cleavage neutralization apparatus.

145. The process of claim 143 further comprising washing the APC decanter organic stream with aqueous

30 alkali base under APC decanter organic stream washing conditions effective to remove trace phenol and to produce a first washed APC decanter organic stream;

35 separating the first washed APC decanter organic stream under first washed APC decanter organic stream separation conditions effective to produce a first washed APC decanter aqueous phase and a first washed APC decanter organic phase.

146. The process of claim 1 wherein said oxidation mixture further comprises an amount of oxidation base effective to increase production of said product hydroperoxide and decrease production of byproducts from components selected from the group consisting of AP,  
5 DMBA, EMBA, and combinations thereof, said oxidation base comprising a quantity of water insufficient to create a separate aqueous phase.

147. The process of claim 146 wherein said oxidation  
10 base is selected from the group consisting of alkali bases, anhydrous ammonia, and aqueous ammonia.

148. The process of claim 146 wherein said alkali base is selected from the group consisting of alkali metal carbonates and alkali metal bicarbonates.

15 149. The process of claim 146 wherein said oxidation base is aqueous ammonia comprising an amount of water effective to increase neutralization of acids formed during the oxidation by the oxidation base.

150. The process of claim 146 wherein said amount of  
20 water is from about 400 ppm to about 2 wt.%.

151. The process of claim 146 wherein said amount of oxidation base is sufficient to produce a ratio of base to acids of from about 0:1 to about 6:1.

152. The process of claim 146 wherein said amount of  
25 oxidation base is sufficient to produce a ratio of base to acids of from about 0.5:1 to about 4:1.

153. The process of claim 149 wherein said amount of oxidation base is sufficient to produce a ratio of base to acids formed under said oxidation conditions of from  
30 about 0:1 to about 6:1.

154. The process of claim 150 wherein said amount of oxidation base is sufficient to produce a ratio of base to acids formed under said oxidation conditions of from about 0:1 to about 6:1.

155. The process of claim 150 wherein said amount of  
35 base is sufficient to produce a ratio of neutralizing base to acids formed under said oxidation conditions of from about 0.5:1 to about 4:1.

156. A process for producing controllable yields of a combination of products selected from the group consisting of (a) phenol and MEK, and (b) phenol, acetone, and MEK, said process comprising:

- 5       feeding an oxidation feed to a series of continuous oxidation reactors to produce an oxidation mixture and feeding a source of molecular oxygen to the oxidation mixture, the oxidation feed comprising one or more alkylbenzenes
- 10       selected from the group consisting of (a) a content of s-butylbenzene (b) a combination comprising s-butylbenzene and cumene at a cumene:s-butylbenzene ratio;
- 15       exposing the oxidation mixture to oxidation conditions effective to produce an oxidation product stream comprising product hydroperoxides selected from the group consisting of (a) s-butylbenzene hydroperoxide, and (b) a combination comprising s-butylbenzene
- 20       hydroperoxide and cumene hydroperoxide;
- 25       separating the oxidation product stream under oxidation separation conditions effective to produce an OB and an oxidation vapor overhead;
- 30       feeding the OB and a quantity of water to one or more strippers and exposing the OB to stripping conditions effective to concentrate but ineffective to decompose said product hydroperoxides, the stripping conditions being effective to produce a stripper overhead and a
- 35       stripper bottoms comprising the hydroperoxides, said quantity of water being effective to produce a first condenser vapor phase comprising a majority of water, ethanol, methanol, methyl hydroperoxide, ethyl hydroperoxide, and combinations thereof, in the first stripper overhead;
- wherein the stripping conditions comprise first stripper conditions effective to produce a first stripper bottoms and a first

stripper overhead comprising a portion of  
the one or more alkylbenzenes;  
second stripper conditions effective to produce  
a second stripper overhead and a second  
5 stripper bottoms, and  
third stripper conditions effective to produce  
a third stripper overhead and third  
stripper bottoms,  
wherein said stripping conditions comprise a  
10 first stripper pressure greater than a  
second stripper pressure greater than a  
third stripper pressure;  
exposing the first stripper overhead to first  
stripper overhead condenser conditions  
15 comprising a first stripper overhead  
condensation temperature and a first stripper  
overhead condensation pressure, said first  
stripper overhead condenser conditions being  
effective to cause a majority of the one or  
20 more alkylbenzenes in the first stripper  
overhead to condense, producing a first  
condenser organic phase, said first stripper  
overhead condenser conditions and said quantity  
of water also being effective to produce a  
25 first condenser vapor phase comprising a  
majority of water, ethanol, methanol, methyl  
hydroperoxide, ethyl hydroperoxide, and  
combinations thereof, in the first stripper  
overhead;  
30 separating the first condenser vapor phase from the  
first condenser organic phase;  
subjecting the first condenser vapor phase to second  
condensation conditions effective to form a  
second condenser organic phase and a second  
35 condenser aqueous phase comprising a majority  
of each of the ethanol, the methanol, the  
methyl hydroperoxide, the ethyl hydroperoxide,  
and combinations thereof in the first condenser  
vapor phase;

decomposing the second condenser aqueous phase under thermal decomposition conditions effective to decompose hydroperoxides selected from the group consisting of ethyl hydroperoxide, methyl hydroperoxide, and combinations thereof, to produce a thermal decomposition product comprising alcohols, aldehydes, carboxylic acids, and combinations thereof, said thermal decomposition conditions comprising a thermal decomposition temperature of from about 80°C to 250°C and a thermal decomposition pressure of from about 100 psig to about 200 psig; feeding to a first cleavage reactor at least a portion of the third stripper bottoms and an acid catalyst to produce a first cleavage reaction mixture, said acid catalyst being effective to catalyze the cleavage of hydroperoxides selected from the group consisting of s-butylbenzene hydroperoxide, cumene hydroperoxide, and combinations thereof, exposing the first cleavage reaction mixture to first cleavage reaction conditions effective to produce a first cleavage reaction product, said first cleavage reaction conditions comprising a first cleavage reaction temperature of from about 45°C to about 70°C, a first cleavage reaction pressure sufficiently high to maintain the first cleavage reaction mixture in the liquid phase, and a first cleavage reaction residence time of from about 1 to about 10 minutes; subjecting the first cleavage reaction product to second cleavage reaction conditions effective to produce a second cleavage reaction product, said second cleavage reaction conditions comprising a second cleavage reaction temperature of from about 60 °C to about 130 °C, a second cleavage reaction pressure sufficient

to maintain the second cleavage reaction mixture in the liquid phase, and a first cleavage reaction residence time of from about 5 seconds to about 1 minute;

5       cooling and neutralizing the second cleavage reaction product with a second cleavage reaction product neutralizing base under second cleavage reaction product neutralization conditions effective to produce a neutralized

10       second cleavage reaction product, said second cleavage reaction product neutralization conditions comprising a second cleavage reaction product neutralization pressure sufficient to maintain the second cleavage

15       reaction product in the liquid phase; and, separating the neutralized second cleavage reaction product into a neutralized second cleavage reaction product aqueous fraction and a CKC feed comprising a neutralized second cleavage

20       reaction product organic fraction; feeding the CKC feed to a Crude Ketone Column (CKC) and exposing the CKC feed to CKC conditions effective to produce a crude phenol fraction comprising from about 2 wt.% to about 5 wt.% of

25       the one or more alkylbenzenes, AMS, AES, 2P2B, and a CKC vapor distillate comprising most of the one or more alkylbenzenes, water, AMS, AES, 2P2B, and combinations thereof in the CKC feed;

30       condensing the CKC vapor distillate to produce a CKC vapor condensate, said condensing comprising feeding the CKC vapor distillate to a CKC vapor condenser and subjecting the CKC vapor distillate to CKC vapor condenser conditions effective to produce the CKC vapor condensate;

35       and, exposing the CKC vapor condensate to CKC vapor condensate separation conditions effective to produce a CKC vapor condensate organic layer and a CKC vapor condensate aqueous layer;

feeding a CKC recycle portion of the CKC vapor  
condensate aqueous layer to the CKC column at a  
recycle point;  
mixing a remainder of the CKC vapor condensate  
5 aqueous layer with the CKC vapor condensate  
organic layer to form a CKC vapor condensate  
mixture comprising 2 wt.% phenol or less;  
recovering a product selected from the group  
consisting of (a) a MEK product and (b) a  
10 combination comprising a MEK product and an  
acetone product.

157. The process of claim 156 said recovering a  
product comprises recovering a MEK product, said process  
further comprising:  
15 mixing the CKC vapor condensate mixture with an  
amount of a MEK recovery alkali base effective  
to condense a majority of aldehydes in the CKC  
vapor condensate mixture with MEK and to  
convert a majority of phenol in the CKC vapor  
20 condensate to sodium phenate, thereby producing  
a MEK recovery mixture; and,  
cooling the MEK recovery mixture to a MEK recovery  
temperature of from about 35 °C to about 55 °C  
to produce a cooled MEK recovery mixture;  
25 decanting the cooled MEK recovery mixture under MEK  
recovery mixture decanting conditions effective  
to separate the cooled MEK recovery mixture  
into a MEK decanter aqueous stream and a MEK  
decanter organic stream comprising MEK,  
30 hydrocarbon, other organic species, dissolved  
water, and combinations thereof;  
washing the MEK decanter organic stream with aqueous  
alkali base under MEK decanter organic stream  
washing conditions effective to remove trace  
35 phenol, producing a first washed MEK decanter  
organic stream;  
separating the first washed MEK decanter organic  
stream under first washed MEK decanter organic

stream separating conditions effective to  
separate the first washed MEK decanter organic  
stream into a first washed MEK decanter aqueous  
phase and a first washed MEK decanter organic  
5 stream;  
washing the first washed MEK decanter organic stream  
with an aqueous wash under conditions effective  
to remove trace alkali base and to produce a  
twice washed MEK decanter organic stream;  
10 exposing the twice washed MEK decanter organic  
stream to twice washed MEK decanter organic  
phase separation conditions effective to  
produce a twice washed MEK decanter aqueous  
phase and a MDC feed comprising a twice washed  
15 MEK decanter organic phase comprising MEK,  
hydrocarbon, water, other organic species, and  
combinations thereof;  
subjecting the MDC feed to MDC conditions effective  
to produce a MDC overhead comprising water and  
20 organic species having a boiling point  
sufficiently lower than MEK to be separated  
from the MEK, and a MDC bottoms comprising MEK  
hydrocarbon, and organic species having a  
boiling point the same as or greater than MEK;  
25 subjecting the MDC bottoms to MPC conditions  
effective to separate the MDC bottoms into a  
MPC bottoms comprising hydrocarbons and organic  
species having a boiling point higher than MEK  
and a MPC overhead comprising an MPC purge  
30 stream comprising MEK, said MPC conditions also  
being effective to produce MEK product as a  
side draw from the MPC.

158. The process of claim 156 wherein said  
recovering a product comprises recovering a MEK product  
35 and an acetone product, said process further comprising:  
feeding the CKC vapor condensate mixture to an  
Acetone Product Column (APC) as an APC feed and  
subjecting the APC feed to APC conditions  
effective to produce an APC product comprising



an APC overhead comprising an APC purge stream comprising acetone, said APC product further comprising substantially pure product acetone as a side draw;

5 wherein the APC conditions comprise:  
feeding to the APC column an APC base effective to catalyze the condensation of aldehydes in the APC feed with MEK and acetone to produce an APC bottoms comprising MEK, hydrocarbon, APC

10 condensation reaction products, sodium phenate, and combinations thereof; and,  
subjecting the APC bottoms to MEK separation conditions effective to separate MEK product.

159. The process of claim 158 wherein the MEK

15 separation conditions comprise:  
cooling the APC bottoms to a temperature of from about 35 °C to about 55 °C;  
exposing the cooled APC bottoms to APC separation conditions effective to produce a first APC

20 aqueous stream and a first APC organic stream comprising MEK, hydrocarbon, other organic species, dissolved water, and combinations thereof;

washing the first APC organic stream with aqueous

25 alkali base under first APC organic stream washing conditions effective to remove trace phenol and to produce a first washed APC organic stream;

exposing the first washed APC organic stream to

30 first washed APC organic stream separation conditions effective to produce a first washed APC aqueous phase and a first washed APC organic phase;

washing the first washed APC organic phase with an

35 aqueous wash under conditions effective to remove trace alkali base and to produce a twice washed APC organic stream; and,

separating the twice washed APC organic stream under  
twice washed APC organic stream separation  
conditions effective to produce a MDC feed  
comprising a twice washed APC organic phase and  
5 a twice washed APC aqueous phase.

160. The process of claim 158 wherein the MEK  
separation conditions comprise:

cooling the APC bottoms to a temperature of from  
about 35 °C to about 55 °C;  
10 decanting the cooled APC bottoms into a cooled APC  
decanter aqueous stream and a cooled APC  
decanter organic stream comprising MEK,  
hydrocarbon, other organic species, dissolved  
water, and combinations thereof;  
15 washing the cooled APC decanter organic stream with  
aqueous alkali base under APC decanter organic  
stream washing conditions effective to remove  
trace phenol and to produce a first washed APC  
decanter organic stream; and,  
20 exposing the first washed APC decanter organic  
stream to APC decanter organic stream  
separation conditions effective to produce a  
first washed APC decanter aqueous phase and a  
first washed APC decanter organic phase.

25 161. The process of claim 156 further comprising  
feeding to a first cleavage reactor an amount of a  
recycle stream effective to reduce the production of non-  
recoverable by-products from DMBA, EMBA, and a  
combination thereof, said recycle stream being selected  
30 from the group consisting of the MPC purge stream, the  
APC purge stream, and a combination thereof.

162. The process of claim 157 further comprising  
feeding to the first cleavage reactor an amount of a  
recycle stream effective to reduce the production of non-  
35 recoverable by-products from DMBA, EMBA, and a  
combination thereof, said recycle stream being selected  
from the group consisting of the MPC purge stream, the  
APC purge stream, and a combination thereof.

163. The process of claim 158 further comprising feeding to the first cleavage reactor an amount of a recycle stream effective to reduce the production of non-recoverable by-products from DMBA, EMBA, and a  
5 combination thereof, said recycle stream being selected from the group consisting of the MPC purge stream, the APC purge stream, and a combination thereof.

164. The process of claim 159 further comprising feeding to the first cleavage reactor an amount of a  
10 recycle stream effective to reduce the production of non-recoverable by-products from DMBA, EMBA, and a combination thereof, said recycle stream being selected from the group consisting of the MPC purge stream, the APC purge stream, and a combination thereof.

15 165. The process of claim 160 further comprising feeding to the first cleavage reactor an amount of a recycle stream effective to reduce the production of non-recoverable by-products from DMBA, EMBA, and a combination thereof, said recycle stream being selected  
20 from the group consisting of the MPC purge stream, the APC purge stream, and a combination thereof.

166. The process of claim 156 wherein the MDC conditions comprise a MDC entrainer effective to remove water from the MDC feed.

25 167. The process of claim 166 wherein the MDC entrainer is selected from the group consisting of hexane, cyclohexane, heptane, and combinations thereof.

168. The process of claim 166 wherein the MDC entrainer is cyclohexane.

30 169. The process of claim 165 wherein the MDC conditions comprise a MDC entrainer effective to remove water from the MDC feed.

170. The process of claim 169 wherein the MDC entrainer is selected from the group consisting of  
35 hexane, cyclohexane, heptane, and combinations thereof.

171. The process of claim 169 wherein the MDC entrainer is cyclohexane.

172. The process of claim 156 wherein said oxidation mixture further comprises an amount of oxidation base

effective to increase production of said product hydroperoxide and decrease production of byproducts from components selected from the group consisting of AP, DMBA, EMBA, and combinations thereof, said oxidation base  
5 comprising a quantity of water insufficient to create a separate aqueous phase.

173. The process of claim 172 wherein said oxidation base is selected from the group consisting of alkali bases, anhydrous ammonia, and aqueous ammonia.

10 174. The process of claim 173 wherein said alkali base is selected from the group consisting of alkali metal carbonates and alkali metal bicarbonate

175. The process of claim 172 wherein said oxidation base is aqueous ammonia comprising an amount of water  
15 effective to increase neutralization of acids formed during the oxidation by the oxidation base.

176. The process of claim 172 wherein said amount of water is from about 400 ppm to about 2 wt.%.

177. The process of claim 172 wherein said amount of  
20 oxidation base is sufficient to produce a ratio of base to acids of from about 0:1 to about 6:1.

178. The process of claim 172 wherein said amount of oxidation base is sufficient to produce a ratio of base to acids of from about 0.5:1 to about 4:1.

25 179. The process of claim 175 wherein said amount of oxidation base is sufficient to produce a ratio of base to acids formed under said oxidation conditions of from about 0:1 to about 6:1.

180. The process of claim 176 wherein said amount of  
30 oxidation base is sufficient to produce a ratio of base to acids formed under said oxidation conditions of from about 0:1 to about 6:1.

181. The process of claim 176 wherein said amount of  
35 oxidation base is sufficient to produce a ratio of base to acids formed under said oxidation conditions of from about 0.5:1 to about 4:1.

182. The process of claim 171 wherein said oxidation mixture further comprises an amount of oxidation base effective to increase production of said product

hydroperoxide and decrease production of byproducts from components selected from the group consisting of AP, DMBA, EMBA, and combinations thereof, said neutralizing base comprising a quantity of water insufficient to  
5 create a separate aqueous phase.

183. The process of claim 182 wherein said oxidation base is selected from the group consisting of alkali bases, anhydrous ammonia, and aqueous ammonia.

184. The process of claim 183 wherein said alkali  
10 base is selected from the group consisting of alkali metal carbonates and alkali metal bicarbonate

185. The process of claim 183 wherein said oxidation base is aqueous ammonia comprising an amount of water effective to increase neutralization of acids formed  
15 during the oxidation by the oxidation base.

186. The process of claim 182 wherein said amount of water is from about 400 ppm to about 2 wt.%.

187. The process of claim 182 wherein said amount of oxidation base is sufficient to produce a ratio of base to  
20 acids of from about 0:1 to about 6:1.

188. The process of claim 182 wherein said amount of oxidation base is sufficient to produce a ratio of base to acids of from about 0.5:1 to about 4:1.

189. The process of claim 186 wherein said amount of  
25 oxidation base is sufficient to produce a ratio of base to acids formed under said oxidation conditions of from about 0:1 to about 6:1.

190. The process of claim 187 wherein said amount of oxidation base is sufficient to produce a ratio of base  
30 to acids formed under said oxidation conditions of from about 0:1 to about 6:1.

191. The process of claim 187 wherein said amount of oxidation base is sufficient to produce a ratio of base to acids formed under said oxidation conditions of from  
35 about 0.5:1 to about 4:1.

192. The process of claim 156 wherein said oxidation separation conditions comprise washing said oxidation product stream under oxidation product washing conditions

effective to remove salts formed in the oxidation and to produce said first condenser vapor phase.

193. The process of claim 191 wherein said oxidation separation conditions comprise washing said oxidation  
5 product stream under oxidation product washing conditions effective to remove salts formed in the oxidation and to produce said first condenser vapor phase.

194. A process for producing controllable yields of phenol, acetone, and methyl ethyl ketone, the process  
10 comprising:

feeding an oxidation feed to an oxidation reactor to produce an oxidation mixture, the oxidation feed comprising a combination comprising cumene and s-butylbenzene, wherein the amount of  
15 cumene is from greater than 15 wt.% to less than 30 wt.% relative to the content of s-butylbenzene;

exposing the oxidation mixture to oxidation conditions effective to produce an oxidation  
20 product stream comprising s-butylbenzene hydroperoxide and cumene hydroperoxide; and, cleaving the product hydroperoxides under cleavage conditions effective to produce a cleavage product comprising phenol, acetone, methyl  
25 ethyl ketone;

separating the cleavage product under separation conditions effective to separate a crude phenol fraction comprising phenol and a crude ketone stream comprising methyl ethyl ketone (MEK) and  
30 acetone; and,

subjecting the crude ketone stream to a ketone separation conditions effective to produce an acetone product and a methyl ethyl ketone product.

35 195. A process for producing phenol, methyl ethyl ketone, and acetone comprising:

feeding an oxidation feed comprising a weight ratio of cumene:s-butylbenzene of from about 1:8 (or 12.5 wt.% cumene) to about 2:1 (or about 66.7

wt.% cumene) to an oxidation reactor to produce  
an oxidation mixture, the oxidation feed;  
exposing the oxidation mixture to oxidation  
conditions effective to produce an oxidation  
5 product stream comprising s-butylbenzene  
hydroperoxide and cumene hydroperoxide;  
cleaving the s-butylbenzene hydroperoxide and cumene  
hydroperoxide under cleavage conditions  
effective to produce a cleavage product  
10 comprising phenol, acetone, and methyl ethyl  
ketone;  
separating the cleavage product under separation  
conditions effective to separate a crude phenol  
fraction comprising phenol and a crude ketone  
15 stream comprising methyl ethyl ketone (MEK) and  
acetone; and,  
subjecting the crude ketone stream to ketone  
separation conditions effective to produce an  
acetone product and a methyl ethyl ketone  
20 product.